MADRAS FISHERIES BUREAU.

NOTE ON TREATMENT OF SWAMPS,

STREAM BEDS, PONDS, WELLS, POOLS, AND OTHER MOSQUITO-INFESTED AREAS FOR THE DESTRUCTION OF THEIR LARVÆ

BY

HENRY C. WILSON,

Piscicultural Expert to the Government of Madras.

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BY

HENRY C. WILSON,

PISCICULTURAL EXPERT TO THE GOVERNMENT OF MADRAS.

THE UTILITY OF FISH AS LARVICIDES.

When we come to consider that the great majority of fresh water fry rely for their sustenance chiefly on aquatic larvæ it seems surprising at first that any larvæ remain to come to maturity in waters stocked with fish.

Immediately after the absorption of the yolk sac the fry commence feeding on minute organisms, such as microscopic crustacea, and, later, on the eggs and larvæ of aquatic diptera.

That they play an important part in keeping down fly pests, such as mosquitos, etc. is an undoubted fact and, if it were not for their presence, we would have millions of mosquitos where we have hundreds now. There is of course a limit to their usefulness in this respect, for, so many mosquito-breeding places exist that are unsuitable for fish, and even in suitable waters surface weeds, etc. protect the larvæ from their enemies.

Chiefly owing to this latter reason the practical utility of fish as larvicides has been decried. The absurdity of this opinion is evident as the fish are not likely to abstain voluntarily from eating the most important item of their natural diet and consequently must take a continuous and heavy toll of larvæ. If the waters are conserved, then a greater percentage of larvæ would be destroyed. Even in the foulest of ill-kept waters they do a certain amount of good, and a careful observer will often see them searching the weed and debris for larvæ and seldom unsuccessfully.

To go to the opposite extreme (which I learn has been done in some cases) of putting oil and cresol into ponds where fish existed, is most unwise and fatal to other small life as well as larvæ. In the first place you not only destroy the fish, but also all small under-water life including other valuable (minute) larvicides, and secondly the effect of cresol and oil is only of a temporary nature and, if not regularly repeated, the pond, etc. so treated becomes a doubly dangerous mosquito-breeding ground.

From a piscicultural point of view the introduction of poisonous substances into waters where fish can be used should be strictly prohibited. The trouble of clearing surface weeds or conserving ponds, etc. is infinitely less than repeated cresoling and oiling and the benefit of the former has the advantage of being more permanent. The cresol and oil treatment is most excellent for, and should be confined to, small isolated puddles or pools too small or of too temporary a character to stock with fish.

SUGGESTED TREATMENT FOR PONDS.

When introducing fish into ponds for purposes of destroying mosquito larvæ, it is necessary to conserve such waters by the removal of surface weeds and floating debris near the margins and draining or filling in isolated pools near the foreshore. The value of this conservancy became apparent to me during my earliest experiments with fish as larvicides. The ponds which were selected for the first experiments were comparatively clear of surface weeds and floating debris and mosquito larvæ could be found near the margin. They were stocked with larvæ-eating fish and after a few days were thoroughly examined with the result that no larvæ could be traced *excepting above some patches of surface weed*; this weed was promptly removed and a further search was made the following day with a negative result.

The margin of ponds, etc. should be trimmed and over-hanging plants that reach to the surface of the water should be cut back, as these tend to hold up debris and protect the larvæ. All small isolated puddles should be filled in or drained. It is just as easy to keep a neat margin to a pond as a neat border to a garden.

BURROW PITS.

The depressions formed when constructing the bunds of irrigation tanks, railways, etc. in India form extensive breeding grounds for mosquitos. The best method I think of dealing with these

burrow pits where it is impossible to drain them, is either to fill them in or treat them similarly to ordinary ponds by clearing weeds, etc. and stocking with suitable fish. Fortunately at the present time a large number of small fish find their way into some of the pits and help to keep the larvæ down. In some districts however, these fish are netted out wholesale by fishermen using casting nets of the smallest mesh. I would suggest that Government adopt the following methods of dealing with these pits :—

(1) If the levels permit, drain the pits off ; if not,

(2) fill in or, where they are extensive and hold water for long periods,

(3) link up each burrow pit by digging an open trench between them, taking care that the sides of the trench are sufficiently sloped to prevent the top soil falling in and blocking them. Clear all pond weeds and debris and stock with suitable fish. These trenches will permit the free access of fish to all the pits and should any of the higher level depressions dry for a short period re-stocking when they fill again, would occur naturally.

(4) Prohibit all fishing in these pits.

(5) When new tanks are being constructed or repairs being made to old bunds make it compulsory to take the earth for the bund from the bed of the tank and not from outside the bund.

SHALLOW SWAMPS, ISOLATED POOLS, ETC.

In dealing with shallow swamps, isolated pools, etc. in malaria-infected districts, I would suggest that the best method would be to trench the entire areas and drain off wherever possible. If it is found impossible to drain a swamp in a malarial tract owing to the nature of the country, then construct a pond at its lowest level and drain the swamp by open trenches into the pond. This pond would have to be kept clean similar to the others mentioned above and stocked with suitable fish. It may be necessary to cross-trench to get at all the little puddles of water held up; but if properly done and kept in order, it would, I think, certainly pay in the long run. Many isolated pools which form from percolation or from heavy rains could in most cases be drained off by these open trenches.

OPEN WATER CHANNELS.

Where water is taken by small open channels for irrigation purposes, etc. in malaria-infected areas its course should be clearly

defined and all obstructions which form little backwaters, removed; the sides should be protected by stone slabs throughout the malarial zone. If this is done the odds against the larvæ in their struggle for existence are enormous and very few are likely to survive. Where cross-channels are taken off the main, care should be taken to avoid the formation of pools, and properly constructed culverts should be adopted. The channel can be made entirely harmless, but generally in the case of a garden supply there is a receptacle for storing small quantities of water; these are sometimes just hollows dug out of the earth, but in many cases small concrete tanks are built; all these should be abolished.

WELLS.

All wells should be kept clear of debris and weed and stocked with suitable fish. In the town of Cuddapah, for example, 50 per cent of the wells were found infested with larvæ of the malaria-carrying mosquito A. *stephensi*. The stocking of these wells with fish larvicides had a very decided and immediate result; heavily infested wells were found free from larvæ three days after the introduction of suitable fish (Haplochilus).

LARGE TANKS.

Mosquitos seldom lay eggs in large, open or wind-swept stretches of water, but select secluded shallows where the wave action is absent. The danger of these tanks generally lies in the unevenness of the foreshore and as the water recedes puddles are left which are inaccessible to fish larvicides. These depressions, where possible, should be drained by trenches into the tank; if the levels do not permit of this, they should be filled in. In fact the whole of the foreshore in the malarial zone should be conserved and all debris or floating matter in the sheltered bays cleared. If stocked with suitable fish when the tank first starts to fill, they will have time to multiply and be of great value in keeping the larvæ down.

PADDY FIELDS.

The destruction of small fish by basket traps of minute mesh should be prohibited in all paddy fields in malarial districts and if larvæ are found after this the fields should be re-stocked with suitable fish. If the above suggestions are carried out the field can be kept comparatively free from larvæ. The paddy fields

form splendid feeding grounds for the small *Haplochilus* and these can be found in large numbers where not interfered with by basket traps, etc. In the Tanjore district and up the West Coast where fish food is plentiful and the paddy fields are not trapped, they simply swarm with small larvæ eating fish, especially *Haplochilus*.

ESTUARIES, BACKWATERS, SALT AND BRACKISH POOLS NEAR THE COAST.

A careful search should be made along the shores of the estuaries and backwaters and all isolated pools within the malarial area should either be filled in (if small) or an open trench dug into the estuary or backwater to enable fish to have clear access. All sea-weed and decomposing debris should be removed from these pools. Fish will soon discover the larvæ and rapidly destroy them. At Ennore where most of the breeding places inside a prescribed area were filled in by Major Ross, I discovered a salt water pool on the shores of the backwater with one living mass of larvæ. As their breeding areas had been restricted the mosquitos had evidently bred in this small pool in thousands. It was shallow, not more than 6 to 8 inches at the deepest part, but was cut off from the backwater by a small sandbank. I divided this pond into sections and cut a channel from one into the backwater deep enough to allow small fish a clear passage. I removed all sea-weed and debris from both sections and examined the following morning. Fish were found in the one section and most of the larvæ were destroyed, only a few remaining in the shallowest portion; whereas in the other isolated section they were teeming. The sides of the former were sloped to make it deeper round the margins and the same evening an examination proved the fish had cleared the lot of larvæ out of the section opened to the backwater. Backwaters as a rule when open to the sea contain an abundant supply of larvicides in the way of small fish, and an examination along the shores where fish have free access will prove that there are very few larvæ; but, on the other hand, when the bars of the backwaters are closed and netting is carried on along the margins by men using small mesh nets, you will find numerous mosquito larvæ. The supply of fish larvicides is depleted and no fresh supply can come in from the sea. In the case of brackish isolated pools where it is either too expensive or

difficult to fill them in, they should be drained and attended to similarly to fresh water ponds or stocked with suitable fish as per list given below.

STREAM BEDS.

All stream beds should be conserved where they pass through malarial zones. To carry this out effectively the banks require to be given a gentle slope to the normal bed of the stream where the channel should be clearly defined throughout its course within the malarial area. Where the natural flood banks are very wide apart and where hollows exist between them and the normal channel holding water for considerable periods, these should be, if the levels permit, linked up by trenches and drained into the main channel or filled in. If the normal bed of the river is swampy and overgrown with reeds and grass, these should be cleared and an uninterrupted defined course given to the normal stream. Where there is a tendency for the river to form a subsidiary deep course during floods, permanent sections to be formed about every 100 feet to prevent future scouring and to facilitate the recovery of the sections of bed if erosion ever occurs. The waters should be stocked with suitable fish larvicides and fishing strictly prohibited.

Hollows formed by the action of running water and stones on the surface of rocks in river-beds form ideal breeding grounds for mosquitos, where the larvæ are free from most of their enemies. These places can often be found black with mosquito larvæ, and I would suggest where they exist in malaria-infected areas to have their water holding capacity destroyed. This could be done either by filling in or by dynamite or in most cases with a stone mason's chisel and hammer by simply knocking a drainage channel into each hollow. As it takes many years for these to form, the above measures need not be repeated for a long period. To fill them in, portland cement would be advisable.

CASUARINA PLANTATIONS.

Holes dug for the purpose of obtaining water for young casuarina trees form most dangerous mosquito-breeding places and these can be found in every plantation along the coast. The water from these pits is only required during the dry months of the first two years after planting, and the holes containing water remain for many years afterwards untouched and unused. There is not the slightest reason why these should be allowed to remain

forming as they do dangerous mosquito-breeding grounds. In the interests of public health the Government might compel the owners of plantations to fill up all such pits, but in any case these danger zones should be abolished.

COCOANUT PLANTATIONS.

In many cocoanut plantations especially on the West Coast it has been the custom to dig trenches about four feet deep and extending a considerable distance among the trees. The water in these trenches appears to be used largely for soaking cocoanut leaves for purposes of making thatties and consequently becomes very foul. Mosquito larvæ can always be found in these places in large numbers.

It is useless stocking them with fish for the following reasons, viz. :—

(1) It is impossible for the fish to destroy the larvæ owing to the presence of the soaking cocoanut leaves and other debris.

(2) After a time owing to the foulness of the water the fish become sick and eventually die.

As these trenches do not serve any very useful purpose they should be filled in.

STREET DRAINS.

Badly constructed street drains where water is held up, are always infected with mosquito larvæ. The constant cleaning of drains that have a natural earth bottom causes inequalities or depressions which hold water for periods sufficiently long for mosquito larvæ to come to maturity.

If sufficient fall can be obtained, then it is best to build a pucca drain with concrete sides and bottom. If it is impossible to get rid of all water, then kerosine oil should be used freely at least once a week.

DRAINAGE CHANNELS ON THE SEA COAST.

All drainage channels which are subject to tidal influence are generally found free of larvæ and well stocked with larvæ eating fish. But wherever these are obstructed by cross bunds they form dangerous mosquito-breeding grounds. All obstructions should be removed and the highest reaches possible brought under tidal influence.

MOST SUITABLE GROUNDS FOR MOSQUITO LARVÆ AND THEIR NATURAL ENEMIES.

The places selected by malaria-carrying mosquitos for depositing their eggs are very numerous and vary from large swamps, ponds, etc., down to the small collection of water in the hollow of a tree or broken chatti pot.

During Major T. S. Ross's inspections in Southern India on special malarial duty he generally found the malaria-carrying anophelines under the following conditions, viz. :—

A. *culicifacies* is most ubiquitous in its selection, but generally prefers clear water.

A. *barbirostris* in tanks, shady pools, pot holes in rocks, stagnant waters, etc.

A. *fulliginosus* in marshes, swamps, paddy fields, etc.

A. *stephensi* in wells, puddles, cisterns, etc.

A. *willmori* in hill streams and marshes.

NATURAL ENEMIES.

Where tall reeds (jambu grass) exist, not many anopheline or other larvæ can be found and I put this down either to the small fish or to the presence of minute crustaceans. Some years ago (1909) I observed some of these crustaceans (*Daphnidæ*-fam.) attacking the eggs of a species of Yellow dun (*Ephemeridæ*) very common in the Kurnool-Cuddapah Canal. Again when hatching experiments were being carried out with the eggs and fry of *Ophiocephalus striatus* both were attacked and destroyed by these minute crustaceans. I identified the most persistent of these as "Daphne pulex," and the method of attack on the fry was to bite into the embryonic caudal fin and tap the caudal vein. The little fish soon died from loss of blood. Mosquito larvæ were introduced into the tank and they were promptly attacked and killed. The method adopted in this case appeared to consist in nipping off or pulling out the long lateral hairs until the larvæ were unable to regain the surface and so dropped to the bottom where they were seized and evidently their vital juices extracted. That they are valuable larvicides is undoubted as they swarm amongst the reeds of most tanks.

The larvæ and full grown beetles of the *Dytiscidæ* are also useful enemies of mosquito larvæ.

Another larvicide common in stagnant waters is the Notonecta glauca.

The young of most of the fresh water indigenous fishes of India attack and destroy mosquito larvæ: but as some grow to a large size they are only useful during the fry stage. In selecting the best of the larvicides it is only necessary to include those that rely chiefly on the larvæ for their food supply it being their natural diet. The following selection will be found a very useful one, the geographical distribution of each genus being widespread:—

FOR TANKS, BIG PONDS AND SWAMPS THE FOLLOWING ARE MOST SUITABLE, VIZ.—

Genus-*Chela.*

Description of genus (Dr. Day)—Body elongate and compressed: abdominal edge cutting. Mouth directed somewhat upwards with the lower jaw prominent. Barbels absent. Pharyngeal teeth hooked and slender, in two or three rows. Dorsal fin short, without any osseous ray, situated principally or entirely opposite the anal, which latter has an elongated base. Pectorals long. Caudal forked. Scales of moderate or small size. Lateral line concave.

Geographical distribution (Dr. Day)—Sind, Continent of India, Burma, and extending to Malay Archipelago.

These fish are surface feeders and their chief diet consists of flies and larvæ. (All species good, the smaller ones being the best.)

Genus-*Rasbora.*

Description of genus.—Abdomen rounded. Cleft of mouth oblique, lower jaw slightly prominent, having one central and on either side a lateral prominence, fitting into corresponding emarginations in the upper jaw. Barbels two (rostral) or none. Eyes with free lids. Pharyngeal teeth. Dorsal fin without any osseous ray and few branched ones, inserted posterior to the origin of the ventral, but not extending to above the anal, which latter is short. Scales large or of moderate size. Lateral line concave continued to the middle or lower half of the caudal fin. Gill rakers short.

Geographical distribution.—Africa, India, Ceylon, Burma to the Malay Archipelago.

All species.

Genus-*Barilius.*

Description of genus.—Abdomen rounded. Mouth anterior, sometimes oblique, having a moderate or deep cleft. Jaws compressed,

the lower usually with a knob above the symphysis, and an emargination to receive it in the upper jaw. Barbels four, two or none: occasionally very rudimentary ones are present. Pharyngeal teeth in two or three rows, hooked. Dorsal fin without osseous ray, of moderate length, inserted posteriorly to the ventrals, sometimes extending to above the anal, which latter is somewhat elongated. Scales of moderate or small size. Lateral line concave, continued on the middle or lower half of the caudal or incomplete or absent. Gill rakers very short or even absent.

Geographical distribution.—India, Ceylon, Burma, Malay Archipelago: also found in the Nile and East Africa.

Small species best.

Genus-*Haplochilus.*

Description of genus.—Body somewhat elongated and compressed. Upper surface of head and nape broad and depressed. Teeth villiform in the jaws, present or absent in the palate. Dorsal fin short, commencing behind the origin of anal, which latter has an elongated base. Scales cycloid and of medium size. Lateral line absent. A white occipital spot invariably present.

NOTE.—This occipital spot is under control and if the small fish is frightened or for other reasons it can render it invisible.

Geographical distribution.—India to the Malay Archipelago and beyond, tropical Africa, Madagascar and islands in the Indian Ocean: also temperate and tropical America.

All species good.

Genus-*Barbus.*

Description of genus.—Mouth arched and anterior or inferior. Jaws closely invested by the lips, which may have leathery lobes but no horny covering. Barbels four: or two: or none. Eyes without adipose lids. Pharyngeal teeth. Dorsal fin rather short, commencing nearly opposite the root of the ventral: its last undivided ray being either ossified and serrated or entire or articulated and not osseous: and rather short in some species its second ray ossified or its last undivided ray may even be serrated. Scales large, of moderate or small size, anal scales not enlarged. Lateral line may be complete or incomplete, when the former it is continued to opposite the centre of the base of the caudal fin.

Geographical distribution.—Throughout Europe, Asia and Africa.

The small species of this extensive genus are most valuable larvæ destroyers.

FOR PADDY FIELDS, WELLS AND SMALL PONDS, ETC.—

All species of *Chelas*, *Haplochilus* and *Polyacanthus*.

FOR SALT OR BRACKISH WATER PONDS, ETC.—

Genus-*Therapon*.

Description of genus.—Branchiostegals six. Eyes of moderate size. Opercle with spines. Preopercle and sometimes preorbital serrated. Teeth villiform in both jaws, the outer row being sometimes the larger: deciduous ones on the vomer and palatines. Dorsal fin single but more or less notched, having from eleven to thirteen spines: anal with three. Scales of moderate or small size. Air vessel divided by a constriction.

Geographical distribution.—From the Red Sea and East Coast of Africa through the seas and estuaries of India to the Malay Archipelago and north coast of Australia.

"*Therapon jarbua*" is a most useful species and can be found in all backwaters and will live and thrive in brackish and fresh water ponds.

Genus-*Polyacanthus*.

Description of genus.—Body oblong, compressed. Mouth small and but little protractile. Opercles spineless. Teeth small and fixed in the jaws, palate edentulous. Dorsal fin single, the spinous portion of much greater extent than the soft: the anal of a similar description: ventral with one spine and five well developed rays, some of which are usually elongated. Scales rather large, ctenoid. Lateral line interrupted and may be partially or even entirely absent.

Geographical distribution.—Fresh waters and estuaries along the coast of India and Ceylon.

"*Polyacanthus cupanus*" is a most valuable larvæ destroyer for both fresh and brackish water, and can be carried any distance with the greatest of ease without change of water, as it obtains oxygen direct from the atmosphere.

DESTRUCTION OF IMMATURE FRY AND USEFUL LARVICIDES.

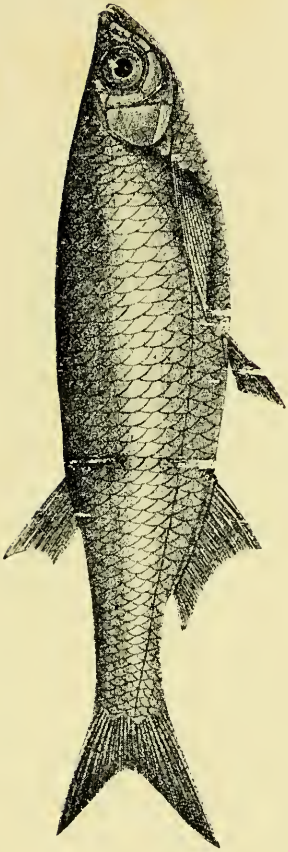
The practice of trapping streams by inserting fixed engines (basket traps Plates 7–9) from bank to bank and the use of fine mesh nets the strands or meshes of which would not allow the smallest fish to pass through, is a most destructive method of fishing.

As it is in the interest of public health to preserve as many of the small fish larvicides as possible, some action to prevent their wholesale destruction is absolutely necessary. If such fishing cannot be abolished altogether the mesh of nets or interstices of basket traps should be regulated and the users licensed. In districts where this is carried on to a large extent mosquitos are naturally most prevalent.

H. C. WILSON,
Piscicultural Expert to the Government of Madras.

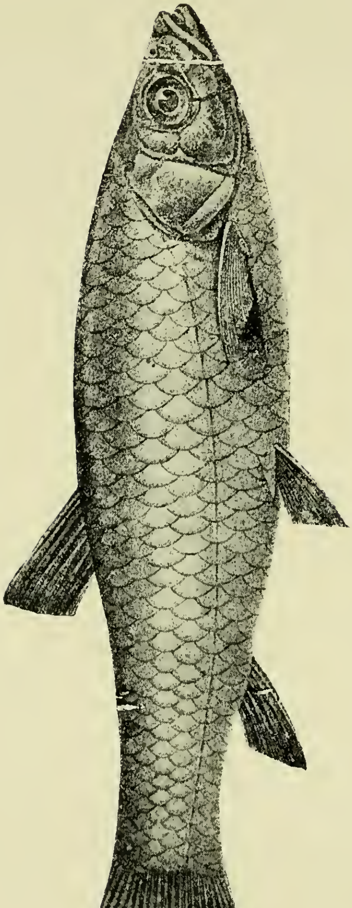
(CAMP) KURNOOL,
Dated 6th February 1914.

PLATE No 1



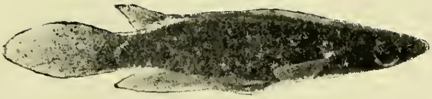
CHELA ARGENTEA.

PLATE No 2



RASBORA DANICONIUS

PLATE No. 3.



HAPLOCHILUS LINEATUM.

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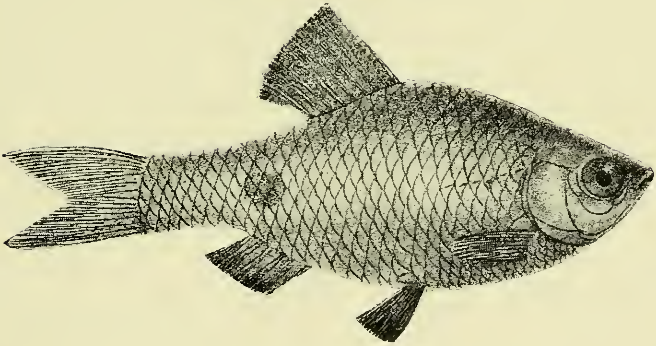

BARBUS TICTO.

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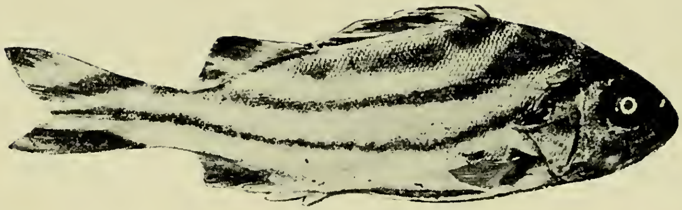

Therapon Jarbua.

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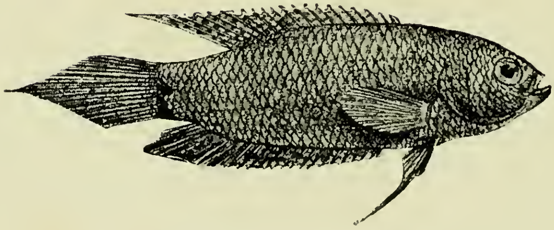
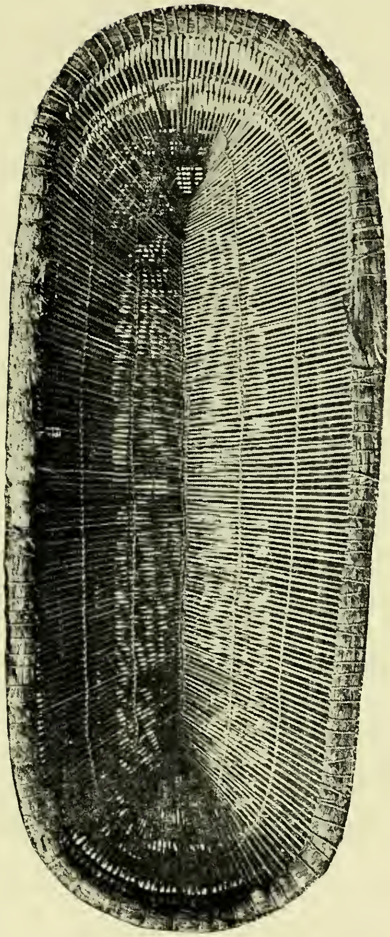


Polyacanthus Cupanus

PLATE No. 7.



BASKET TRAP.
LARGELY USED FOR CAPTURE OF SMALL FISH.

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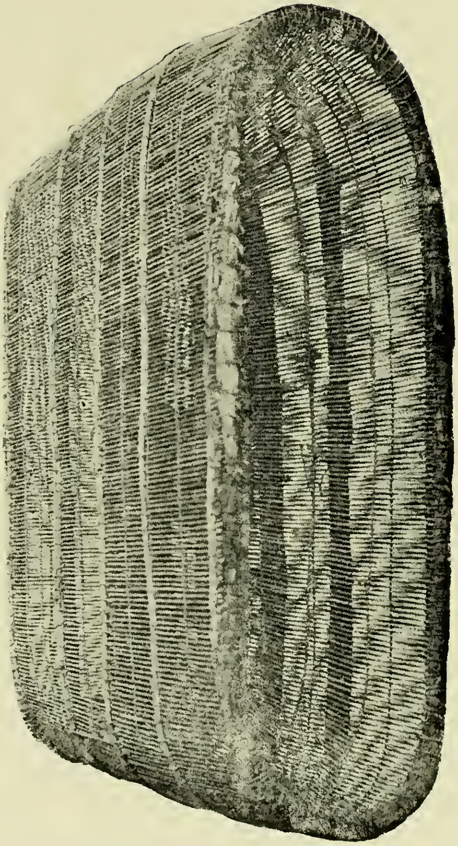

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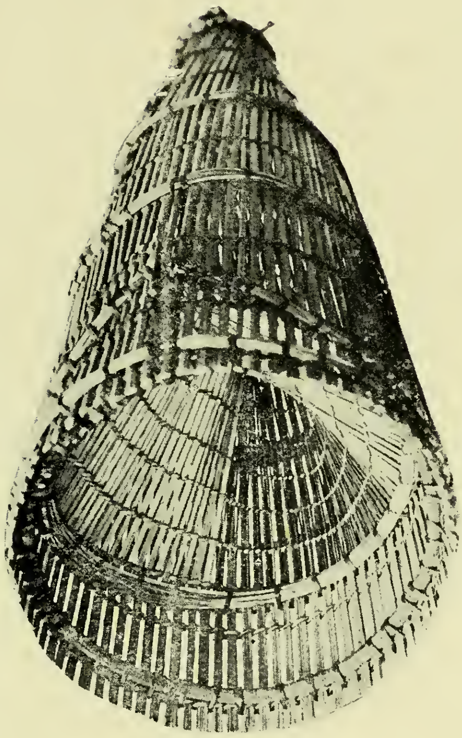

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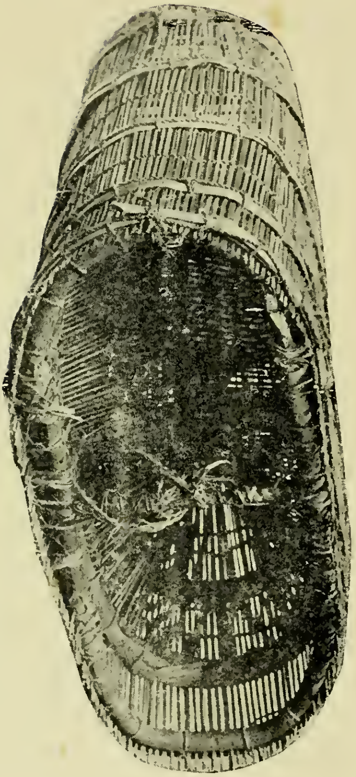

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